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DEPARTMENT OF THE INTERIOR

UNITED STATES BUREAU OF MINES
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BY

WING G. AGNEW

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DEPARTMENT OF THE INTERIOR - BUREAU OF MINES

UNDERGROUND MILL AT THE DOYLE MINE, SHULLSBURG, WIS.[1]

By Wing G. Agnew[2]

It is thought that a brief description of the unique mining and milling procedure at the Doyle mine may be interesting to those engaged in small-scale operations at old mines or in working a new ore body adjacent to old workings. It also shows what can be done with a small capital outlay in working a zinc-lead mine on a small scale; as the operation herein described was begun 3 years ago with four men and it now employs 17 men.

The original idea was to mine out any ore left around the edges of some old stopes above the water level and to rob pillars after an old stope became filled with waste and tailings. This has been done, and the procedure is still being followed; at the same time a paying lead is being mined toward an area in which churn-drill holes have shown ore. Also, preparations are now being made to do some pumping.

The old workings at this mine and those of two connecting worked-out mines cover quite an area, and it was found that by going down in a creek bed nearly a mile away and opening some old churn-drill holes the water level in the old workings was lowered about 8 feet. A shaft is now being sunk on one of the churn-drill holes to the creek level, and a centrifugal pump will be installed to lower the water level an additional 15 feet.

In sinking this shaft for the pump, a profitable body of ore was found just under the surface. This ore will be mined and trucked to a point above the mill and dropped through an 8-inch churn-drill hole that is now being drilled to connect with the mill hopper.

The mill is in an old stope near the bottom of the shaft. One-ton ore cars are hauled up an inclined tramway to an elevation of 30 feet by an electric friction hoist driven by a 3- horsepower motor. The ore is dumped into a 45-ton hopper, from which it is fed into a wet jaw crusher. The 1 1/2-inch material from the crusher is passed through 20-inch wet rolls and is then elevated to a trommel with 1/4-inch openings. The oversize feeds back through the rolls, and the undersize from the trommel goes to a standard battery of eight 24- by 30-inch jigs. Two clean-up tables are to be added to the mill in a short time. The concentrate is loaded into cans, and when 8 or 10 cans are

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filled they are hoisted to the surface and dumped into a concentrate bin, from which they are loaded from a chute into trucks for transportation to the acid plant. The tails are sluiced into an old stope. All the water for the mill is taken from an adjacent old stope by means of a small centrifugal pump. In some of these stopes the water is 40 feet deep. One 20-horsepower electric motor drives the whole mill, which is rated at 120 tons for 24 hours.

The mill is operated in two 8-hour shifts per day, 6 days per week, with three men to a shift. On each shift 40 tons of ore are milled, and 3 tons of concentrate are produced. The concentrate contains iron sulphide and zinc sulphide, running about 35 percent zinc. It is trucked to the acid plant at Cuba City 12 or 13 miles distant, under contract at 85 cents per ton. On the present market (March 1936) the concentrates bring $16 per ton at the acid plant. In addition, a few tons of lead concentrates are produced each month.

The shaft is 110 feet deep, plank-lined, single-compartment, 4 by 4 feet, down to the limestone. An old steam hoist, now belt-driven by a 10-horsepower electric motor, is used to hoist the half-ton cans of concentrates. Air is provided by two portable, single-stage, two-cylinder, belt-driven compressors run at 400 r.p.m. One, 6 by 7 inches in size, is driven by a 20-horsepower motor; and the other, 6 1/4 by 7 inches, is driven by a 15-horsepower motor. The reason for having the larger motor run the smaller compressor is that all the equipment is second-hand and was not installed at the same time. Cooling water, stored in two 50-gallon oil drums, is circulated through the compressors by means of an automobile-engine water pump driven by a 1/4-horsepower electric motor.

Before any mining was done, a flat-bottomed rowboat was taken underground and used in an effort to find the ore along the edges of the old stopes. The boat was used also in stringing old hoisting cables across a stope to make a suspension bridge for tramming with a 1-ton car. Several such bridges have been built to permit reaching isolated areas where the amount of ore in sight justified the expense of such construction.

To obviate dead work as far as possible, the ore is followed as long as it is at or above water level. About 200 feet from the mill the ore "pitched" upward for about 20 feet, which is characteristic of the occurrence in this district. A 14-ton ore bin with grizzly bars 4 inches apart was built at this "pitch", into which ore from the upper level is trammed. From this bin ore is loaded into 1-ton cars and trammed to the mill-hopper incline. On the upper level, a short distance from the "pitch", the ore was followed down a gentle incline, and another friction hoist driven by a 3-horsepower motor was installed to haul up the loaded cars.

The drilling is done with 2 1/4-inch bore, hand-held, machines using 7/8-inch hollow hexagon-collared drill steel. The bits are of the six-point rose type, hot-milled, with the cutting edges depressed at the center hole[3].

3/ Agnew, W.G., Hot Milling of Rock Drill Bits at the Mines of the Vinegar Hill Zinc Co., Platteville, Wis.: Inf. Circ. 6907, Bureau of Mines, 1936. (In press.)

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About 10 pieces of drill steel are used per day. These bits are sharpened at the nearest drill shop, which is some 13 miles distant. All holes are loaded and fired at the end of the shift by the foreman. Powder consumption averages 1 pound of 60 percent to 3 tons of rock broken.

The ore is sorted as it is mucked, and the discarded waste rock is trammed to the nearest old stope. When an old stope becomes filled with waste rock and tailings the pillars are robbed as far as possible.

The miners use carbide lights, but the shaft bottom, mill, and tramming drifts are lighted by electricity.

The mine works one shift 6 days per week. For the whole operation 17 men are employed, as follows: 1 foreman at $5 per day, 3 miners at $3.25, 4 muckers at $3.10, 6 millmen at $3.25, and 4 hoistmen at $2.50. Below is a summary of those costs that were available for March 1936.

Costs per ton of ore mined and milled

Tons of ore mined and milled during period: 2,080.

Source of ore: One drift stope and fringes of old stopes and pillars.

	1 Labor	2 Supervision	3 Compressed-air drills and steel	4 Power cost	5 Explosives	6 Timber	7 Other supplies	8 Total
Mining.....	$0.3394	$0.0625	1/	$0.0875	$0.0492	1/	1/	.5386
Milling.....	.2438	.....	2/	.....	2/	.....	.....	.2438
Surface.....	.0625	.....	2/	.....	2/	.....	.....	.0625
Royalty, 7 percent of gross	.....	.....	.....	.....	.....	.....	.....	$0.0840
Transportation of concentrates.....	.....	.....	.....	.....	.....	.....	.....	.0638
Total.....	.6457	.0625	.....	.0875	.0492	.....	.....	--- .9927

1/ Not available.
2/ None.

Item 1 covers all the labor engaged in the whole operation. Item 2 is the salary of the foreman who supervises all the work. The owner also is active but draws no fixed salary. There were no costs available for item 3. Item 4 is the total power bill for March divided by the number of tons mined and milled. Item 5 is the cost of the powder only, as the amount of caps and fuse used was not available. For item 6 no figures were available on timber, as very little is used except for ties and an occasional chute and most of it is secondhand. There were no figures available for item 7-other supplies, such as oil, carbide, rails, repairs, etc. Item 8 is the total cost for those items on which costs were available, plus the royalty and the cost of transporting the concentrates.

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For the present grade and value of ore and at the current rate of operations the partial costs as detailed above total $0.9927 per ton. This leaves $0.2073 per ton to cover the remaining costs and the owner's profit.

Summary and Conclusions

1. With this method of mining and milling it is possible to begin operations with a very small capital outlay.
2. Hoisting costs are very low because only the concentrates are hoisted.
3. Mill heads are higher because much waste rock is sorted.
4. Milling costs per ton of concentrate are lower because of the higher heads and the cheap disposal of tailings.
5. Tramming costs are lower because it is easy to dispose of waste rock in old stopes.
6. Filling the submerged portion of stopes with discarded waste is an economical method of preparing for the partial extraction of pillars.
7. Pumping costs are kept at a minimum.

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